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Japanese Patent Application JP 2001 - 18344 A

Oriented Composite Polyester Film

Your Ref: 102203 - 17

For: Eastman Chemical Company

(19) Japanese Patent Office (JP)

(11) Unexamined Patent Application No:

Kokai 2001-18344

(P2001-18344A)

(12) Unexamined Patent Gazette (A)

(43) Date of Publication: January 23, 2001

(51) Int. Cl.^{7}		Class. Symbols	FI		Subject Codes (Reference)
B 32 B	27/36		B 32 B	27/36	
	27/20			27/20	Z
G 11 B	5/73		G 11 B	5/73	
	5/733			5/733	

Request for Examination: Yes Number of Claims: 2 OL Total of pages [in original]: 8

(21) Application No.: P2000-175382

(62) Division: Division of JP (Tokugan) 3-215835

(22) Date of Filing: July 31, 1991

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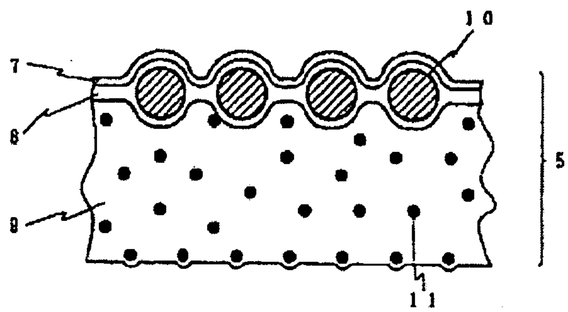
(54) [Title of the Invention] Oriented Composite Polyester Film

(57) [Summary]

[Object] To provide an oriented composite polyester film that has excellent running properties and electromagnetic conversion characteristics, and that causes very little abrasion dust to be generated during the calendering process.

[Means of Achievement] An oriented composite polyester film comprising at least three layers, wherein this oriented composite polyester film is characterized in that the resin layer that forms one of the outermost layers (layer A) is free of particles having a substantial projection-forming capability, the layer next to layer A (layer B) comprises particles having a substantial projection-

forming capability, and the average roughness of the surface on the side of layer B opposite the surface of this layer A is no more than two thirds the average roughness of the surface of layer A.



5: Oriented composite polyester film
7: Layer A
8: Layer B
9: Layer C
10: Inactive particle
11: Inactive particle

[Claims]

[Claim 1] An oriented composite polyester film comprising at least three layers, wherein said oriented composite polyester film is characterized in that the resin layer that forms one of the outermost layers (layer A) is free of particles having a substantial projection-forming capability; the layer next to layer A (layer B) comprises particles having a substantial projection-forming capability; and the average roughness of the surface on the side of layer B opposite the surface of this layer A is no more than two thirds the average roughness of the surface of layer A.

[Claim 2] An oriented composite polyester film comprising three layers, which are layer A, layer B, and layer C, wherein said oriented composite polyester film is characterized in that the resin layer that forms one of the outermost layers (layer A) is free of particles having a substantial projection-forming capability; the layer next to layer A (layer B) comprises particles having a substantial projection-forming capability; and the average roughness of the surface of the outermost layer other than layer A next to layer B (layer C) is no more than two thirds the average roughness of the surface of layer A.

[Detailed Description of the Invention]

[0001]

[Technological Field of the Invention] The present invention relates to an oriented composite polyester film suitable for use as the base film of magnetic tape.

[0002]

[Prior Art] Polyester film has excellent physical and chemical properties and is widely used for a variety of purposes, including magnetic recording. Of these properties, particular importance is attached to surface flatness and running properties when the polyester film is used as the base film of magnetic tape. The method whereby the film surface is roughed by adding inorganic or organic fine particles to the film is a conventional way of improving running properties. Nevertheless, roughing the film is undesirable because it leads to a deterioration of electromagnetic conversion characteristics.

[0003] Moreover, as a result of the implementation of high-speed magnetic tape production processes in recent years, there is a demand for film of even better wear resistance during calendering. Calendering is a process whereby magnetic paint is applied and dried, followed by the smoothing of the resulting surface. However, there is a problem in that because the film passes between rolls that apply very high pressure, the projections on the film surface are scraped off, generating abrasion dust, and a solution to this problem is being sought.

[0004]

[Problems to Be Solved by the Invention] An object of the present invention is to provide an oriented composite polyester film that has excellent running properties and electromagnetic conversion characteristics, and that causes very little abrasion dust to be generated during calendering, even when it is used for magnetic tape.

[0005]

[Means Used to Solve the Above-Mentioned Problems] Aimed at attaining the above-mentioned object, the oriented composite polyester film of the present invention, which comprises at least three layers, is characterized in that the resin layer that forms one of the outermost layers (layer A) is free of particles having a substantial projection-forming capability; the layer next to layer A (layer B) comprises particles having a substantial projection-forming

capability; and the average roughness of the surface on the side of layer B opposite the surface of this layer A is no more than two thirds the average roughness of the surface of layer A. Moreover, in order to accomplish the above-mentioned purpose, the oriented composite film of the present invention, which comprises three layers, that is, layer A, layer B, and layer C, is characterized in that the resin layer that forms one of the outermost layers (layer A) is free of particles having a substantial projection-forming capability; the layer next to layer A (layer B) comprises particles having a substantial projection-forming capability; and the average roughness of the surface of the outermost layer other than layer A next to layer B (layer C) is no more than two thirds the average roughness of the surface of layer A.

[0006] The oriented composite polyester film of the present invention comprises at least three polyester layers. It may have a structure of any number of layers as long as there are three or more layers. The layers other than the above-mentioned three layers can be made of a material other than polyester.

[0007] The polyester in each layer of the oriented composite polyester film of the present invention is not subject to any particular limitations and can be any type of polyester, but the results of the present invention are most obvious when 80 mol% or greater of the repeating units of the polyester are ethylene terephthalate or ethylene-2,6-naphthalate, making this option particularly preferred. It is also possible to arbitrarily select the following components as additional copolymer components: dicarboxylic acid components such as isophthalic acid, p-β-oxyethoxybenzoic acid, 2,6-naphthalenedicarboxylic acid, terephthalic acid, 4,4'-dicarboxyl-diphenyl, 4,4'-dicarboxylbenzophenone, bis(4-carboxyphenyl)ethane, adipic acid, sebacic acid, 5-sodium sulfoisophthalic acid, and cyclohexane-1,4-dicarboxylic acid; glycol components such as propylene glycol, butanediol, neopentyl glycol, diethylene glycol, cyclohexanedimethanol, bisphenol A ethylene oxide adducts, polyethylene glycol, polypropylene glycol, and polytetramethylene glycol; oxycarboxylic acid components such as p-oxybenzoic acid; and the like. Small amounts of compounds with amide bonds, urethane bonds, ether bonds, carbonate bonds, and the like may also be contained as the other copolymer components.

[0008] Any production method, including the method of direct polymerization whereby an aromatic dicarboxylic acid and glycol are reacted directly, and the transesterification method whereby the dimethyl ester of an aromatic dicarboxylic acid and a glycol are subjected to an transesterification reaction, can be used as the method of producing this polyester.

[0009] It is necessary for the resin that forms at least one of the outermost layers (layer A) of the oriented composite polyester film of the present invention to be essentially free of particles having a projection-forming capability. This is because a protective effect against scraping of the projections on the polyester film surface is produced by layer A that is essentially free of particles having a projection-forming capability; therefore, shedding of the projections in the film surface that have been formed based on the particles contained in layer B is prevented and a surface with a markedly reduced generation of abrasion dust during the calendering process can be obtained. The projection-forming capability referred to herein means the ability to form projections with a height of at least 50 nm on the film surface, and this ability can be evaluated with a scanning tunneling microscope or the like. On the other hand, shedding of the film surface projections during calendering tends to occur and there is marked generation of abrasion dust when no protective layer essentially free of particles having a projection-forming capability (layer A) is formed, or when a layer comprising particles having substantial projection-forming capability is used as the outermost layer.

[0010] The layer next to layer A (layer B) of the oriented composite polyester film of the present invention essentially contains particles having a projection-forming capability. Moreover, the surface of layer A (running surface) can be given excellent running properties by a method in which projections are formed on the surface of layer A on the basis of the particles that have been added to layer B.

[0011] Examples of inactive particles with a projection-forming capability are inorganic particles such as carbonates of Ca, Mg, Sr, and Ba; sulfates of Na, K, Mg, Ca, Ba, and Al; phosphates of Na, K, Mg, Ca, Sr, Ba, Al, Ti, and Zr; silicon dioxide; alumina; compound silicon oxides (amorphous or crystalline clay minerals, aluminosilicate compounds, and the like); chrysotile (zircon, fly ash, and the like); oxides of Zr and Ti; terephthalates of Ca, Ba, Zn, and Mn; chromates of Ba and PB; carbon (carbon black, graphite, and the like); glass (glass powder, glass beads, and the like); fluorite; and ZnS; as well as organic particles such as crosslinked polystyrene resin, crosslinked acrylic resin, benzoguanamine resin, silicon resin, and crosslinked polyester resin. Calcium carbonate, inorganic silicic acid, hydrous silicic acid, aluminum oxide, aluminum silicate, barium sulfate, calcium phosphate, zirconium phosphate, titanium oxide, lithium benzoate, glass powder, clay (kaolin, bentonite, mortar, and the like), talc, and diatomaceous earth are preferred examples. These inactive particles can be natural or synthetic.

Moreover, they can be used alone, two or more can be used together, or they can be used in the form of a compound salt.

[0012] The average particle diameter of these inactive particles varies with the thickness, amount, and other attributes of layer A and layer B, but it should be a particle diameter capable of yielding projections with a projection height of about 0.1 to 1 μm on layer A. This particle diameter is usually 0.05 μm to 5.0 μm, and preferably 0.1 μm to 2.5 μm.

[0013] The amount of inactive particles added to layer B is 0.05 to 40 parts by weight, and preferably 0.2 to 10 parts by weight, per 100 parts by weight of polyester.

[0014] It is necessary that the layer other than layer A that is next to layer B (layer C) of the oriented composite polyester film of the present invention be essentially free of particles having a projection-forming capability, or that the particles comprising layer B include particles having an average particle diameter that is no more than two thirds the average particle diameter of particles with the largest average particle diameter (that is, 3 μm or less, and preferably 0.05 to 1.5 μm). Furthermore, it is preferred that when the film has a three-layered structure, particles be added to layer C in order to give slip properties to the side that is opposite the surface of layer A (the side on which the magnetic layer is preferably formed in the case of magnetic tape).

[0015] Particles with the same composition as the particles that were given as examples of inactive particles with a projection-forming capability can also be cited as examples of particles that can be added to layer C. Moreover, it is possible to essentially prevent the formation of projections toward the surface of layer A (running side in the case of magnetic tape) by particles that have been added to layer C by keeping the average particle diameter of the particles that can be added to layer C within the above-mentioned range. Consequently, the projections on the surface of layer A are composed essentially from the particles that have been added to layer B, and it is possible to obtain a running surface that has uniform, high-density projections and that may, for instance, have excellent electromagnetic conversion characteristics and running properties. On the other hand, when particles having an average particle diameter that falls outside the above-mentioned range are added to layer C, projections will be formed on the surface of layer A by the particles that have been added to layer C, the projections on the running side will be nonuniform, the roughness of the magnetic side (side opposite the surface of layer A) may therefore be high, and there will be a deterioration in the electromagnetic conversion characteristics.

[0016] The amount of inactive particles added to layer C is 0.01 to 10 parts by weight, and preferably 0.04 to 2 parts by weight, per 100 parts by weight of polyester.

[0017] The thickness of layer A (Ta), the thickness of layer B (Tb), and the thickness of the entire film (Tf) of the polyester film of the present invention should satisfy the following correlation:

$$Ta + Tb < (1/3)\ Tf$$

[0018] In general, although the running properties are improved when the running side of the tape is roughed, electromagnetic conversion characteristics deteriorate with transfer of the roughness of the running side to the surface of the magnetic layer. However, a running side (layer A surface) with a very small transfer effect can be obtained by keeping Ta + Tb within the above-mentioned range to obtain a magnetic recording film with excellent electromagnetic conversion characteristics and running properties. On the other hand, if Ta + Tb are outside the above-mentioned range, there will be considerable transfer of the roughness of the running side to the magnetic side, the magnetic side will be roughed, and the electromagnetic conversion characteristics will be poor.

[0019] Consequently, electromagnetic conversion characteristics improve when layer A and layer B are thinner, but layer A must have a sufficient protective effect on the running side in order to ensure reduced calendering abrasion. Moreover, if layer A is too thick, the projections on the film surface will tend to be flattened by the coating effect thereof, and the running properties will tend to be adversely affected. Ta is preferably 0.01 to 2 μm, and more preferably 0.05 to 1 μm. Ta should be less than one fifth of Tf. On the other hand, although there are no special restrictions to the lower limit of Tb, Tb should be 0.05 to 3 μm, and particularly 0.1 to 2 μm, in order to ensure excellent running properties. Tf should be 3 to 300 μm, and particularly 5 to 20 μm. The thickness of layer A and layer B can be evaluated by secondary ion mass spectroscopy (SIMS) or the like.

[0020] There are no special restrictions on the surface roughness of the oriented composite polyester film of the present invention and it can have any surface roughness, but it is preferred that the average roughness on one side is no more than two thirds the average roughness on the other side. Preferably, the rough side is the surface of layer A and the average roughness is 0.010 to 0.030 μm. This is because the roughing on the surface of the magnetic layer surface due to the substrate effect can be suppressed by forming the magnetic layer on the flat side, and the

surface of layer A will hardly be capable of roughing the surface of the magnetic layer through a transfer effect, making it possible to provide even better electromagnetic conversion characteristics. The average roughness (Ra) of a surface is the centerline average roughness as measured under conditions corresponding to a needle diameter of 2 μm, a load of 0.07 g, a measurement standard length of 0.8 mm, and a cutoff of 0.08 mm using the surface roughness meter Surfcom 300A made by Tokyo Seimitsu Co., Ltd.

[0021] There are no special restrictions and any method can be used to produce the oriented composite polyester film of the present invention. For example, the film can be produced as follows. That is, the polyesters that form layer A, layer B, and layer C are each melted, laminated, and coextruded, a film is then obtained by biaxial drawing, and a heat treatment is conducted by a conventional method. The drawing sequence can be longitudinal-transverse, transverse-longitudinal, or simultaneous biaxial. It is also possible to draw the film in three or more steps using any combination of transverse drawing, longitudinal drawing, and simultaneous biaxial drawing. The heat treatment is performed in a tenter after biaxial drawing, and it is preferred that the heat treatment be performed for 2 to 10 seconds at 190 to 230°C. Moreover, it is also possible to perform relaxation treatment in the transverse and longitudinal directions during or after the heat treatment.

[0022] A magnetic layer is formed on one side of the film when the oriented composite polyester film of the present invention is used for magnetic tape. The magnetic layer can be formed on either side of the film, but it is preferred that the surface of layer A be used as the running side, and a magnetic layer be formed on the side opposite the surface of layer A because the effect of the present invention will be the most obvious. Moreover, a back coat on the running side is optional, but when the surface of layer A is used as the running side, excellent running properties can be obtained even if there is no back coat.

[0023]

[Working Examples] A working example of the oriented composite polyester film of the present invention is shown in Fig. 2. In Fig. 2, 7 is layer A, 8 is layer B, 9 is layer C, 10 is the inactive particles, and 11 is the inactive particles. Moreover, production of the polyester and evaluation of projection-forming capability were performed as described below.

Production of polyester and evaluation of projection-forming capability

When polyester was polymerized by conventional methods, each type of particle shown in Table 1 was added at the time of polymerization to produce polyethylene terephthalate with an intrinsic viscosity of 0.620 (PET-1 through PET-5). Next, each of the resulting polyesters (PET-1 through PET-4) was dried, melted at 290°C, and cast onto a cooling drum at 30°C to obtain an undrawn film with a thickness of 220 μm. This film was then heated using a roll heated to 75°C and an infrared heater with a surface temperature of 600°C (placed 20 mm from the film). Then the film was drawn 330% in the longitudinal direction between a low-speed roll and a high-speed roll. This film was further guided to a tenter, drawn 440% in the transverse direction at 100°C, and heat treated for 5 seconds at 220°C to yield a biaxially oriented polyester film with a thickness of 15 μm. The projection-forming capability of each particle was evaluated using the film obtained in this way. The results are summarized in Table 1.

[0024] Measurement of particle diameter and projection-forming capability of the inactive particles in Table 1 was performed as follows.

(1) Particle diameter of inactive particles

Powder was thoroughly dispersed in an ethylene glycol (EG) slurry by high-speed stirring, and then the particle diameter distribution of the resulting slurry was measured using the light-transmitting particle diameter distribution meter of the centrifugal sedimentation type SA-CP3 made by Shimadzu Corp. The integrated 50% value was used in this distribution.

[0025] (2) Projection-forming capability

After sputtering 5 nm of white palladium on a film surface, the film surface was observed using the scanning tunneling microscope STA350 made by Seiko Instruments, first at a magnification of approximately 2000× (objective lens 50×) under an optical microscope attached to the same device. Film in which numerous projections (approximately one/20 μm^2) had been formed by inactive particles was evaluated as having a projection-forming capability. A location devoid of projections formed by anomalous aggregation of particles on a film in which projections were difficult to observe was also selected under the optical microscope, the revolving stage was switched from the optical microscope to the scanner of the tunneling microscope, and the surface shape of a 20 μm^2 area in this location was measured with the tunneling microscope (number of pixels = 256 pixels × 128 lines). Gradient correction and smoothing were performed on the surface shape that was obtained from the tunneling

microscope measurements, and the height distribution of the number of peaks and the height distribution of the number of pixels (histogram) were then measured. Moreover, films in which the number of peaks less than 50 nm was 95% or greater of the total number of peaks (maximum number of peaks) was regarded as those that did not have a substantial projection-forming capability, taking the height corresponding to the maximum number of pixels as zero level. With a film in which the number of peaks in an area of 20 μm^2 was less than 100, the same measurements were repeated until the number of peaks reached 100.

[0026] Working Examples 1 through 3, Comparative Examples 1 through 3

The polyesters that formed each of layer A, layer B, and layer C in Table 2 were each dried and then fed to individual extruders. The percentage of the amount discharged from each extruder was adjusted to obtain the thickness percentage of each layer shown in Table 2. The polyesters were melted at 290°C, laminated using a T-die, and then coextruded onto a cooling drum adjusted to 30°C to obtain an undrawn oriented composite polyester film with a thickness of 220 μm. The undrawn film that was obtained in this way was biaxially extruded and heat treated by exactly the same method as the extrusion method used for the evaluation of projection-forming capability, yielding the oriented composite polyester films shown in Table 2. The thickness of each layer shown in the same table was calculated from the polyester discharge percentage of each layer and from the total thickness of the resulting film.

[0027] Comparative Example 4

As shown in Table 2, other than the fact that layer A was not laminated and a two-layer structure was made using the polyester shown in the same table for layer B and layer C, oriented composite polyester film was made by exactly the same method as in Working Example 1.

[0028] Comparative Examples 5 and 6

As shown in Table 1, other than the fact that layer B was omitted and a two-layer structure was made using the polyester shown in the same table for layer A and layer C, oriented composite polyester film was made by exactly the same method as in Example 1.

[0029] Test Example 1

The calendering wear characteristics, running properties, and electromagnetic conversion characteristics of the oriented composite polyester film of the working examples and comparative examples were studied and average roughness was measured as described below. The results are shown in Table 3.

(1) Calendering wear characteristics

A film with a width of 30 cm was treated on a four-step super-calender (linear pressure: 300 kg/cm, running speed: 300 m/minute) over a distance of 40,000 meters, and the amount of white powder that adhered to an elastic roll was macroscopically observed and ranked as follows.

1: No white powder at all was seen

2: Although faint, a very small amount of white powder was seen

3: A small amount of white powder was seen

4: A large amount of white powder was seen

[0030] (2) Running properties

Running properties were studied using the device in Fig. 1 under conditions corresponding to a temperature of 23°C and a relative humidity of 65%. In Fig. 1, 1 is a crank with a length of 40 mm, 2 is a rotatable guide roller, 3 is a tension detector, and 4 is a commercially available metal guide post for a consumer VCR (maximum roughness Rt = 0.15 μm, average roughness Ra = 0.008 μm). Film 5 with a width of 12.5 mm was passed through the guide roller 2, tension detector 3, and guide post 4; the contact angle relative to this guide post 4 was set at 3π/4 radians; one end of film 5 was connected to crank 1; a 50-g weight 6 was suspended from the other end of the film; crank 1 was rotated at a speed of 8 rpm; and film 5 was moved back and forth 100 times. The coefficient of friction (μk) was measured and evaluated according to the following ranking system.

O: $\mu k < 0.25$

Δ: $0.25 \leqq \mu k \leqq 0.35$

×: $0.35 < \mu k$

[0031] (3) Electromagnetic conversion characteristics

The chroma S/N in relation to standard tape was measured using the TG-7/1 NTSC-TV test signal generator and the 925D/1 NTSC color video noise gauge made by ShibaSoku Co., Ltd. The results were evaluated and ranked according to the following three-step system.

O: S/N > +3dB

Δ S/N > + 1dB

×: S/N < + 1dB

The magnetic tape was produced in the following manner. Magnetic paint whose composition is shown below was applied and dried to a thickness of 5 μm, and the product was super-calendered, heated, and cured. The resulting film was slit to a width of 1/2 inch to make VHS videotape.

1. Magnetic powder (γ-Fe_2O_3)
2. Binder (polyurethane/nitrocellulose)
3. Curing agent (trifunctional isocyanate)
4. Carbon black
5. Abrasive (alumina)
6. Lubricant (stearic acid/isobutyl stearate)
7. Solvent (methyl ethyl ketone/toluene/cyclohexanone)

[0032] (4) Average roughness (Ra)

The average roughness is represented by the centerline average roughness as measured under conditions corresponding to a needle diameter of 2 μm, load of 0.07 g, measurement standard length of 0.8 mm, and cut-off of 0.08 mm using the surface roughness meter Surfcom 300A made by Tokyo Seimitsu Co., Ltd.

[0033]

[Table 1]

Polyester	Inactive particles			Projection-forming capability
	Type	Mean particle diameter	Concentration	
PET-1	Spherical silica	0.23 μm	1500 ppm	Present
PET-2	Spherical silica	0.43 μm	4000 ppm	Present
PET-3	Calcium carbonate	0.60 μm	3000 ppm	Present
PET-4	γ-Alumina	0.02 μm	2000 ppm	Absent
PET-5	Not added			Absent

[0034]

[Table 2]

	Layer A		Layer B		Layer C	
	PET	Thickness	PET	Thickness	PET	Thickness
Working Example 1	PET-5	0.7	PET-3	1.5	PET-1	12.8
Working Example 2	PET-4	0.7	PET-3	1.5	PET-1	12.8
Working Example 3	PET-5	0.7	PET-2	1.5	PET-1	12.8
Comparative Example 1	PET-1	0.7	PET-3	1.5	PET-1	12.8

	Layer A		Layer B		Layer C	
	PET	Thickness	PET	Thickness	PET	Thickness
Comparative Example 2	PET-5	0.7	PET-3	1.5	PET-2	12.8
Comparative Example 3	PET-5	0.7	PET-4	1.5	PET-1	12.8
Comparative Example 4	—	—	PET-3	1.5	PET-1	13.5
Comparative Example 5	PET-5	0.7	—	—	PET-1	14.3
Comparative Example 6	PET-5	0.7	—	—	PET-3	14.3

Thickness unit: µm

[0035]

[Table 3]

	Average Ra (µm)		Calendering wear characteristics	Running properties	Electromagnetic conversion characteristics
	Running side	Magnetic side			
Working Example 1	0.018	0.007	2	O	O
Working Example 2	0.019	0.007	2	O	O
Working Example 3	0.016	0.007	1	O	O
Comparative Example 1	0.020	0.007	3	O	O
Comparative Example 2	0.019	0.018	1	O	×
Comparative Example 3	0.003	0.007	1	×	Could not be evaluated
Comparative Example 4	0.020	0.007	4	O	O
Comparative Example 5	0.005	0.007	1	×	Could not be evaluated
Comparative Example 6	0.024	0.025	2	O	×

[0036] As is clear from the above table, Working Examples 1 through 3, which satisfy the requirements of the present invention, have excellent running properties and electromagnetic conversion characteristics and also have superior calendering wear characteristics. In contrast to this, Comparative Example 4 (which lacked layer A as a layer essentially free of particles with a projection-forming capability) and Comparative Example 1 (which had layer A as a layer essentially containing particles with a projection-forming capability) have excellent running properties and electromagnetic conversion characteristics, but it is clear that their calendering wear characteristics are poor. In addition, it is clear that the film of Comparative Example 3 (which had layer B as a layer essentially free of particles with a projection-forming capability) has inadequate running properties. It is also clear that electromagnetic conversion characteristics are inadequate in Comparative Example 2, where particles having an average particle diameter

exceeding two thirds of the average particle diameter of particles added to layer B were added to layer C. In addition, it is clear that either the running properties or electromagnetic conversion characteristics are poor in Comparative Example 5 and Comparative Example 6, which did not have a thin middle layer (layer B) to which particles having substantial protrusion-forming capability had been added.

[0037]

[Effect of the Invention] The oriented composite polyester film of the present invention has a protective layer that is essentially free of particles having a protrusion-forming capability, and it has a protrusion-forming layer (layer B) that essentially comprises particles with a protrusion-forming capability. Therefore, protrusions that are unlikely to be scraped off during the calendering process are formed uniformly and to a high density in the film surface. The resulting effect is that, for instance, a magnetic tape made from this polyester film has excellent electromagnetic conversion characteristics and running properties, and causes very little generation of white powder during the calendering process, thereby demonstrating excellent properties as film for electromagnetic recording media.

[0038] The main use of the oriented composite polyester film of the present invention is for magnetic recording media, as previously mentioned, but it can be efficiently used for other purposes in which abrasion resistance and running properties pose a problem, including graphics, stamping foil, electric insulation, capacitor dielectrics, packaging, flexible printed circuit boards, and the like.

[Brief Description of the Drawings]

[Fig. 1] A schematic drawing of the tester for determining the running properties of a film

[Fig. 2] A schematic drawing showing an example of oriented composite polyester film

[Key]

1: Crank
2: Guide roller
3: Tension detector
4: Guide post
5: Oriented composite polyester film

6: Weight

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7: Layer A

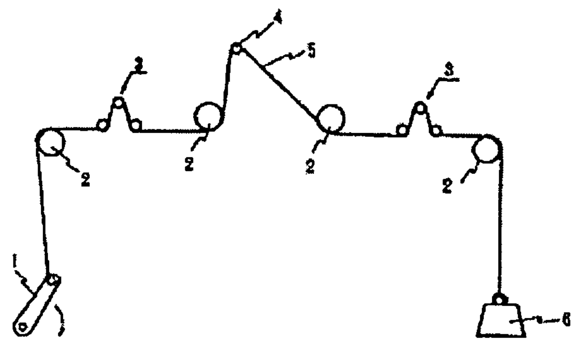
8: Layer B

9: Layer C

10: Inactive particle

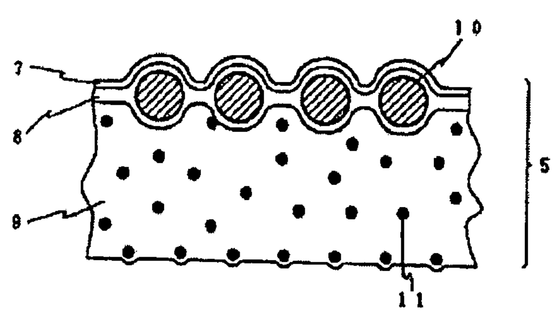
11: Inactive particle

[Fig. 1]



1: Crank
2: Guide roller
3: Tension detector
4: Guide post
5: Oriented composite polyester film
6: Weight

[Fig. 2]



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